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A SURVEY OF BRITISH RESEARCH ON WAVE PROPAGATION WITH PARTICULAR REFERENCE TO TELEVISION

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R. L. SMITH-ROSE, D.Sc., Ph.D., Member

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Since the beginning of the present century, a great deal of scientific research of both a theoretical and experimental nature has been conducted in the United Kingdom on the propagation of radio waves of all frequencies. Depending upon the particular frequencies or wavelengths being studied, this work has involved the investigation of the effects of the ground and upper and lower atmosphere on the propagation, with the view, amongst other objects, of establishing the characteristics of radio waves for various applications, including communication, broadcasting, radar and navigational aids. With the rapidly increasing interest in the development of television, considerable attention has been given in recent years to the problems associated with the frequency bands provisionally allocated for television broadcasting. These bands are located between limits of 41 and 960 Mc/s, and the service at present under development in the United Kingdom is confined to the use of five channels in the band 41–68 Mc/s. For this service to be successful, each transmitting station must establish, over the normal reception area, a satisfactory ratio of the wanted signal to the prevailing noise or other interfering signals. This involves, first, understanding in detail the manner in which the waves carrying the programme signals are propagated within the service area of the station to a radius of about 50 to 100 km (30 to 60 miles); and secondly, establishing, on a statistical basis, the manner in which the waves from any other station operating in the same frequency channel are propagated to considerable distances in sufficient strength to impair, by interference, reception of the wanted programme.

Dr. Smith-Rose is in the Department of Scientific and Industrial Research.

The paper reviews the results of investigations conducted in this country on the propagation of radio waves of the frequencies assigned for the existing and future television services. Within the service area, this propagation is largely determined by the nature of the terrain over which the waves travel, including the effect of hills and valleys, trees, buildings and similar departures from the ideal smooth-earth condition. The effect of the diffraction of waves round the curvature of the earth, or over hills, has been studied, as well as the bending of the waves owing to the vertical gradient of refractive index in the atmosphere. Within the service area the field strength from the transmitter remains reasonably constant, although in built-up areas, or amidst hilly or wooded surroundings, there may be large changes in field strength from place to place, giving rise to "shadow" effects. Variations with time may also occur as a result of interference between the direct wave and the waves reflected or scattered by moving objects such as aircraft. Apart from such interference, the field strengths attained in practice are in reasonable agreement with those estimated from theory.

In recent years, considerable investigation has been carried out on the propagation of radio waves in the metre waveband (frequencies of 30 to 300 Mc/s) at distances of a few hundred kilometres. At such ranges, well beyond the normal optical horizon, the propagation is affected to a major degree by meteorological conditions. The general level of field strength, and the variations superimposed on this, are determined first by the changes in gradient of the refractive index of the atmosphere, and secondly by the presence of temperature inversions which, at heights of one or two kilometres, may act as reflecting layers. Furthermore, at distances approaching the limits of practical

reception, regions of discontinuity of refractive index in the atmosphere may be a source of scattering of radio waves, and may result in an extension of the normal range of transmission.

Under suitable conditions, waves in this frequency band may also be transmitted distances of several thousand kilometres by way of the ionosphere; but experience, up to the present time, suggests that occurrences of reception of this kind are comparatively rare with normal transmitter powers and receiver sensitivities.

Apart from the use of radio links at frequencies in the region of 900 Mc/s, comparatively little opportunity has so far arisen for the study of radio-wave propagation in the band 490–960 Mc/s, in which much of the future development of television is likely to take place. At higher frequencies, between 3 000 and 10 000 Mc/s, several investigations of wave propagation have been made in the past decade in association with the development of centimetre-wave radar. Much of this work was carried out over sea paths, but some of it, conducted over land, has already provided certain information on propagation characteristics, and this will prove of interest in connection with more detailed investigations which are now in progress. It seems likely, however, that the use of such frequencies in a television service will be confined to radio links for point-to-point distribution.